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ABSTRACT

Two developmental studies were conducted to test the influence of incentive magnitude on free recall. The relationship between higher reward and greater recall indicated by previous studies was discussed in terms of two hypotheses: (1) greater recall due to rehearsal; and (2) greater recall explained through motivational arousal theory. Subjects were 5th and 8th graders and college students. Rehearsal and intentive levels were varied, and the results generally supported the rehearsal theory, as incentive level influenced overt rehearsal and did not affect recall scores in the absence of rehearsal opportunities. (DP)

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THE DEVELOPMENT OF INCENTIVE LEVEL INFLUENCE ON OVERT REHEARSAL AND FREE RECALL OF UNRELATED WORDS

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Two developmental studies were conducted to test the influence of incentive magnitude on free recall. These experiments followed two earlier free recall studies by Cuvo and Witryol (1971) and Lurie (1972) which found that children recalled more words associated with a higher rather than lower incentive, when incentive values were cued during item presentation. Since rehearsal was silent in these previous studies and not subject to direct observation, the experimenters speculated that differential covert rehearsal mediated the recall patterns obtained.

The importance of rehearsal as a mediator of incentive magnitude effects on retention has been postulated by Atkinson and Shiffrin (1968), Atkinson and Wickens (1971), and Estes (1969). Reinforcement, these investigators have proposed, is effective because the reward stimulus provides information value for selective rehearsal. This position will be referred to as Rehearsal Theory. An alternate hypothesis suggested by Weiner and his associates (Walker & Tarte, 1963; Weiner, 1966; Weiner, 1967; Weiner & Walker, 1966) argues that incentives heighten motivational arousal thereby inducing more permanent memory traces for stimuli associated with the incentives. Motivational arousal level is directly related to incentive magnitude and facilitates stimulus recall without the benefit of rehearsal. This position will be referred to as Arousal Theory. In light of the extant data, the operation of rehearsal as a mediator of incentive effects in recall needs more careful investigation.

Experiment I, therefore, was proposed to test whether or not an overt rehearsal procedure could be employed to detect theoretical rehearsal mechanisms. Subjects at three different age levels were required to rehearse overtly in part of Experiment I in order to permit a more direct analysis of the incentive level-rehearsal relationship. Specifically, the experiment examined whether or not two monetary incentive levels differentially influenced overt rehearsal of verbal stimuli as well as their free recall. Following Experiment I, a second experiment was conducted, similar to the first, in which rehearsal was presumed to be covert. Experiment I fifth-graders failed to produce an incentive level effect in overt rehearsal as well as free recall; it was decided to test whether the overt rehearsal procedure interfered with differential processing of verbal stimuli by allowing subjects to rehearse covertly instead of overtly.

EXPERIMENT I

Method

Subjects

A sample of 60 subjects - 20 fifth-graders, 20 eighth-graders, and 20 college students - served in Experiment I. All subjects were tested individually by the same experimenter.

Design

The design of Experiment I, as detailed in Table 1 of your handout, consisted of the following variables: Rehearsal (overt vs. minimal), Sex (male vs. female), Grade (5, 8, college), Incentive Level (10¢ vs. 1¢), and Lists (6). Rehearsal, Sex, and Grade were between-subjects variables; Incentive Level and Lists were within-subjects treatments in the 2 x 2 x 3 x 2 x 6 design. Five males and five females from each grade were randomly assigned to the two Rehearsal conditions - Overt Rehearsal and Minimal Rehearsal. Primary dependent variables were words recalled following presentation of each list, words overtly rehearsed during each list presentation, and long-term recall for all six lists combined.

Materials and Apparatus

Verbal stimuli to be learned in the two Rehearsal conditions were six lists of singular nouns with 20 words per list. Lists were controlled to the extent possible for typical verbal learning variables. Red or green cellophane was inserted in the word slides in order to cue either 1¢ or 10¢ incentive values. The colors were counterbalanced with the incentives such that for half the subjects red was a cue for the 1¢ incentive and green cued the 10¢ incentive, and for the other half of the subjects the color-incentive level associations were reversed.

Procedure

The initial step in each of the two Rehearsal conditions was to demonstrate the experimental task to subjects, followed by subjects practicing the procedure. Overt Rehearsal subjects rehearsed the stimulus words aloud without restriction prior to free recall and their rehearsal was tape recorded. Minimal Rehearsal subjects were instructed to say the word aloud only once and then to count backwards by two's between successive verbal stimuli without additional overt or covert rehearsal. Two levels of monetary incentive, 10¢ and 1¢, were associated with words to be recalled in the six experimental lists.

Results

The major results of Experiment I can be shown most succinctly in figures portraying statistical interactions of the primary experimental treatments. Now if you will turn to the next page of your handout, Figure 1 shows the nature of incentive level influence on immediate recall in a second order interaction: Rehearsal x Grade x Incentive Level, $p < .005$. The figure shows immediate recall means for 1¢ and 10¢ words for each Grade tested in both the Overt Rehearsal and Minimal Rehearsal- conditions. A Tukey test showed that college adults recalled significantly more 10¢ words than 1¢ words in the Overt Rehearsal condition.

Eighth-graders in Overt Rehearsal and college subjects in Minimal Rehearsal, Figure 1 shows, seemed to favor 10¢ words but these differences were not reliable.

Figure 2 on the next page shows incentive level effects on overt rehearsal scores in the Grade x Incentive Level interaction, $p < .01$. College adults rehearsed significantly more 10¢ words than 1¢ words but eighth- and fifth-graders did not differentiate between incentive values in Overt Rehearsal. These college data are the only known demonstration of a direct influence of incentive level on rehearsal. Figures 1 and 2 are consistent, indicating that older subjects, college students especially, were the primary contributors of variance to incentive level effects on immediate recall and overt rehearsal.

The overt rehearsal scores were examined further to detect additional developmental differences in rehearsal which might have accounted for the Rehearsal x Grade x Incentive Level interaction for immediate recall. First, the rehearsal scores were examined for number of overt repetitions of a stimulus in the rehearsal set concurrent with the item's presentation (e.g., how many times was the fifth item rehearsed in the fifth rehearsal set). It was found that college subjects overtly rehearsed 10¢ words more frequently immediately following their presentation, than 1¢ items immediately subsequent to their exposure; for this measure, eighth- and fifth-graders did not rehearse differentially. Thus, one factor accounting for the incentive level effect on recall by college adults was sheer repetition of the higher incentive item immediately subsequent to its presentation.

Next, the data were analyzed for re-entry of previously presented words into subsequent rehearsal sets for additional overt rehearsal. Multiple repetitions of the same item were counted in the scores for this analysis. College students, it was found, re-entered 10¢ words more frequently than 1¢ items into subsequent rehearsal sets, but eighth- and fifth-graders did not. Thus, a second factor accounting for incentive level differentiation in recall

by college subjects was favoring 10¢ words rather than 1¢ words for re-entry into subsequent rehearsal sets for additional rehearsal.

The Overt Rehearsal condition rehearsal and recall scores were analyzed further to determine the relative contributions of short-term memory store, rehearsal buffer, and long-term memory store information to list recall. Items rehearsed in subjects' twentieth or final rehearsal sets on each list would have been in the buffer immediately prior to recall. Examining total recall, it was found that approximately half the words recalled derived from the buffer. The additional items recalled could have been retrieved from long-term store and/or a covert rehearsal buffer, contrary to instructions not to rehearse surreptitiously. Analysis of only the first item recalled showed that it was emitted with high probability (.87) from the buffer, rather than long-term store.

The relative contributions of long- and short-term stores to Incentive Level, 10¢ and 1¢, associated recall were examined in the Overt Rehearsal data of college adults only, since they produced greater incentive magnitude differentiation in recall and rehearsal than fifth- and eighth-graders. Figure 3 in your handout shows the proportion of recall for both 10¢ and 1¢ items presented at each of the 20 list positions to college subjects in the Overt Rehearsal condition. The figure shows that incentive magnitude recall differences favoring 10¢ words were contributed at all serial positions except one. Since 10¢ words were recalled better than 1¢ words for the early and middle portions of the list, high incentive items had a higher probability of transfer to long-term memory store than low incentive items.

The third major dependent variable, Long-Term Store recall, showed significant effects on the Grade x Rehearsal x Incentive Level interaction. Significant Incentive Level differences, favoring 10¢ items, were found in the long-term recall for college subjects in both Overt Rehearsal and Minimal Rehearsal conditions. Fifth- and eighth-graders did not produce incentive level effects for either Rehearsal condition.

Finally, the immediate recall data from Experiment I were collapsed for Incentive Level, and serial position curves for each of the two major conditions were plotted. Figure 4 in your handout shows serial position effects for college students tested in the Overt Rehearsal and Minimal Rehearsal conditions. The figure shows typical serial position curves, with prominent primacy and recency effects for Overt Rehearsal conditions in which rehearsal was unimpeded. For Minimal Rehearsal conditions, the serial position curves show reduced primacy effects relative to those found for the Overt Rehearsal condition. However, the Minimal Rehearsal condition shows diminished primacy portions of the serial position curves but a prominent recency portion as a result of minimized rehearsal opportunities. The curves for fifth- and eighth-graders are similar.

Experiment II

In Experiment I, it had been expected that Incentive Level differentiation would obtain in immediate recall and overt rehearsal for all three grades in the Overt Rehearsal condition. The results, however, showed that 10¢ words were recalled and rehearsed more frequently than 1¢ words primarily by college adults, marginally by eighth-graders, but not by fifth-graders. It was decided to examine whether or not the overt rehearsal procedure may have been the culprit precluding incentive magnitude effects on recall for fifth-graders. Experiment II, then, was designed to test whether an incentive level effect on recall would obtain if these 10 year old subjects rehearsed covertly.

A sample of 30 subjects - 10 fifth-graders, 10 eighth-graders, and 10 college students - served in a 3 x 2 experimental design, with Grade (5, 8, college) between subjects and Incentive Level (10¢ vs. 1¢) within subjects. The procedure was basically the same as that for the Experiment I Overt Rehearsal condition, with the single exception that subjects rehearsed covertly rather than overtly.

The principal result of Experiment II was the Grade x Incentive Level interaction. Incentive Level differentiation in recall increased as a function of Grade. Differences between 10¢ and 1¢ word recall was greatest for college adults, intermediate for eighth-graders, and least for fifth-graders. Significant Incentive Level differences obtained for each grade including fifth-grade.

Discussion of Experimental Findings

The data generally support the Rehearsal Theory rather than the Arousal Theory predictions for Incentive Level affects on recall. Primary confirmation of Rehearsal Theory derived from the findings that, in general: (a) Incentive Level influenced overt rehearsal, which mediated similar effects in immediate recall and long-term recall; and, (b) Incentive Level had no affect on recall scores in the absence of rehearsal opportunities. Older subjects, in contrast to the younger ones overtly rehearsed and recalled more 10¢ words than 1¢ words. These results provided the first known demonstration of incentive magnitude influence on overt rehearsal of verbal stimuli and support the theories which postulate that incentive level directly influences rehearsal.

A question of interest was exactly how subjects manipulated their rehearsal processes to produce an Incentive Level effect in recall. Closer examination of the overt rehearsal data showed two specific rehearsal strategies that aided college subjects, especially, in recalling more 10¢ words than 1¢ words: repetition of high incentive associated words immediately following their presentation, and re-entry of previously presented 10¢ items into subsequent rehearsal sets for additional overt rehearsal. Younger subjects did not manipulate these control processes as readily, suggesting a direct relationship between age and ability to manipulate motivationally influenced control processes in memory.

The results are consonant with Estes' (1969, 1971) theoretical position on the function of rewards. For him a meutral stimulus and a reward become associated

when paired contiguously. In this study, neutral stimulus words were paired in close contiguity with one of the two monetary reward values. To the extent that the associations were learned, the differential associated reward values were transferred to the previously neutral stimuli (words) by a differential facilitative feedback mechanism. This resulted in differentially amplifying and weighting the stimulus words, and increased the probability that an overt response occurred during the two minute free recall interval following list presentation.

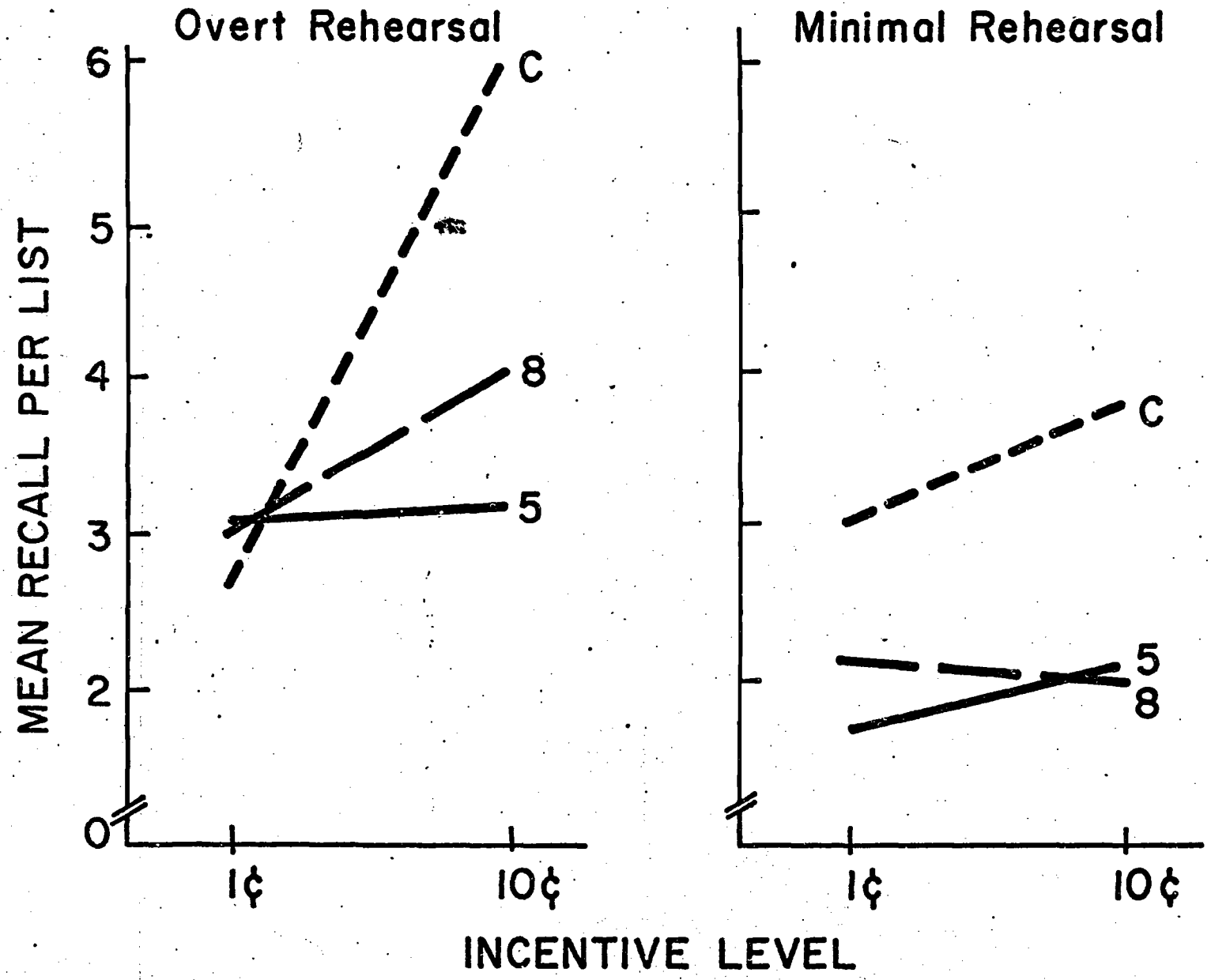
Atkinson and Wickens (1969) stressed the attentional function of rewards as they might apply to the Atkinson and Shiffrin (1968) memory model. Incentive played an attentional role directing the subject to certain features of the stimulus complex but not to others. In the Overt Rehearsal condition, high incentive associated words had higher probability of: (a) entering the short-term store rehearsal buffer; and, (b) receiving more frequent rehearsals.

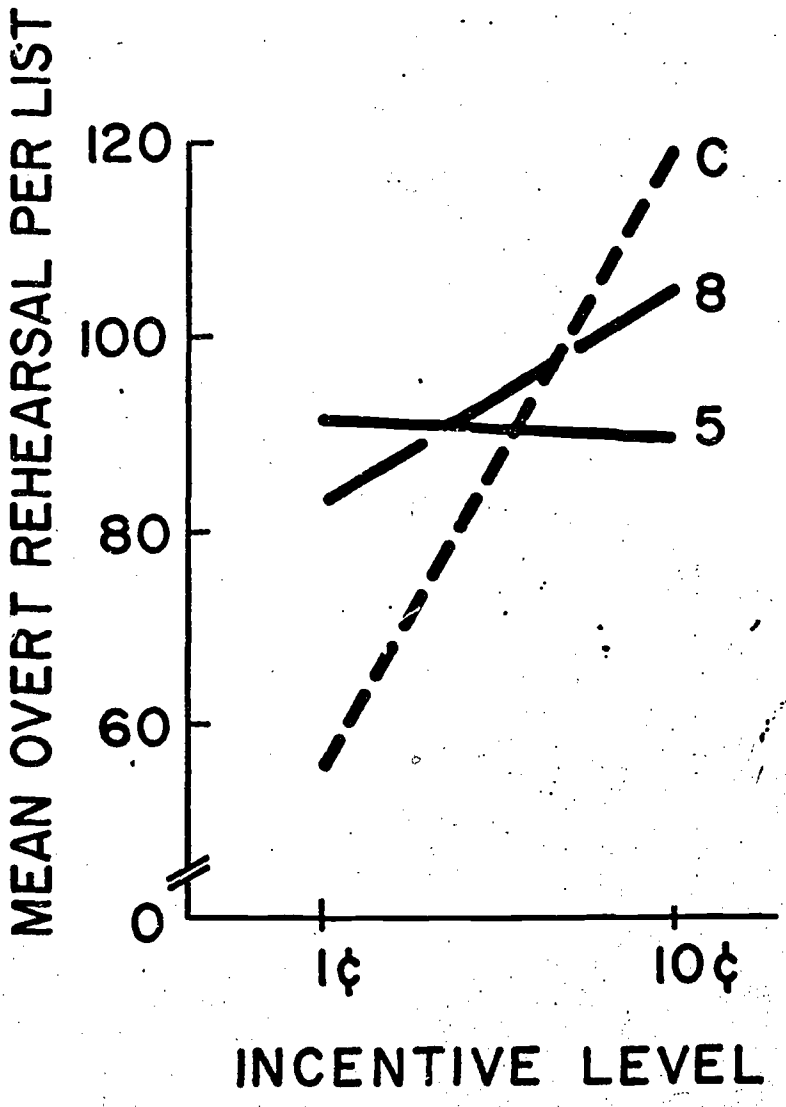
Experiment II was designed to test the effect of Incentive Level on free recall mediated by covert rehearsal. Since rehearsal method was the only procedural difference between Experiment I and II, the overt rehearsal procedure seems to have been responsible for precluding an Incentive Level effect by fifth-graders in the Overt Rehearsal condition on Experiment I. Overt rehearsal, in contrast to covert rehearsal, impeded the differential processing of stimuli according to their incentive associations for fifth-graders, but not for college adults. It can only be conjectured that there was a developmental difference with respect to perceived task demands. Fifth-graders may have interpreted the Experiment I task demands to emphasize sheer overt repetition rather than differential rehearsal. Older subjects, on the other hand, had greater verbal facility, and perceived the task as a differential learning problem.

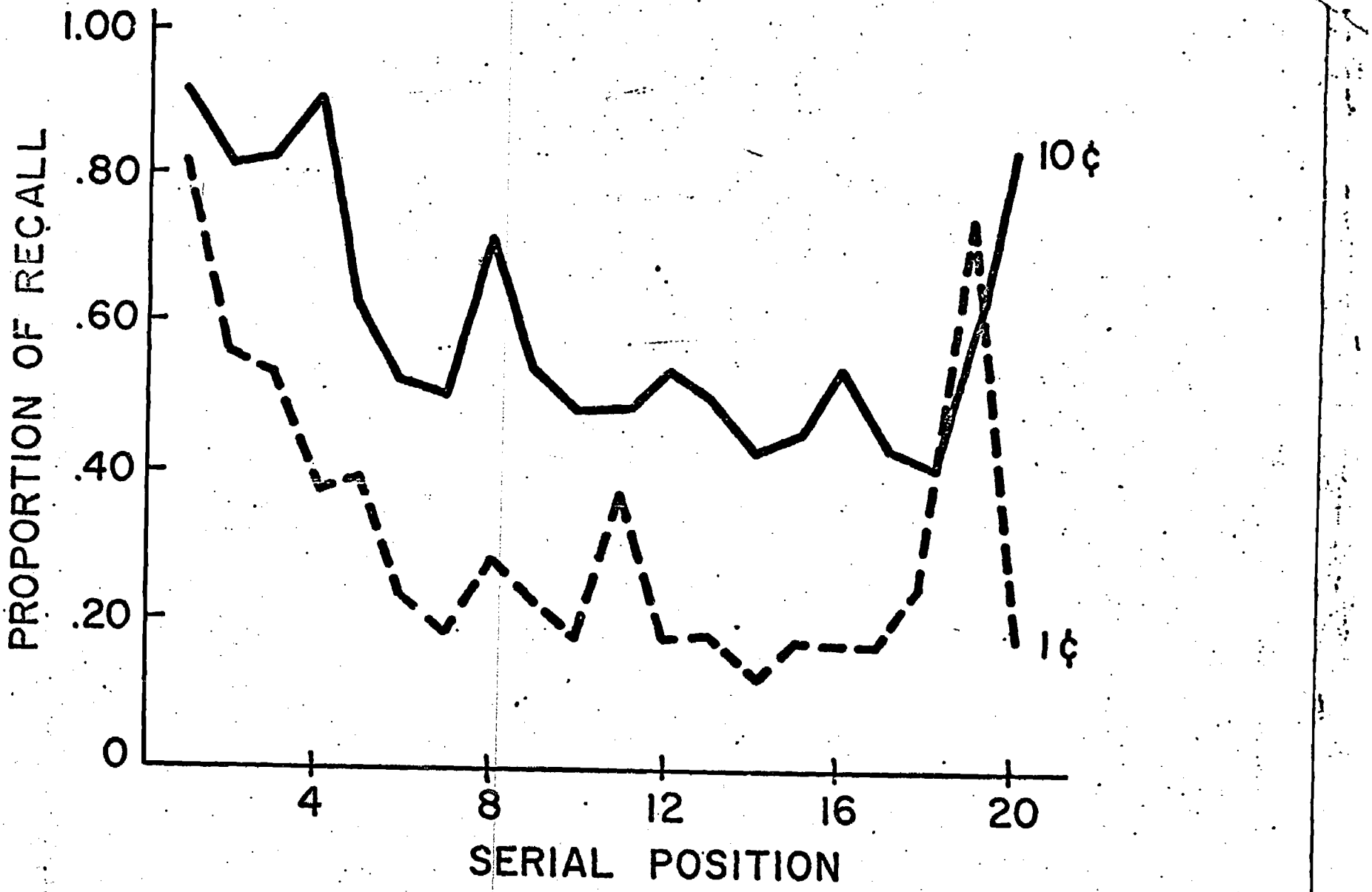
TABLE 1

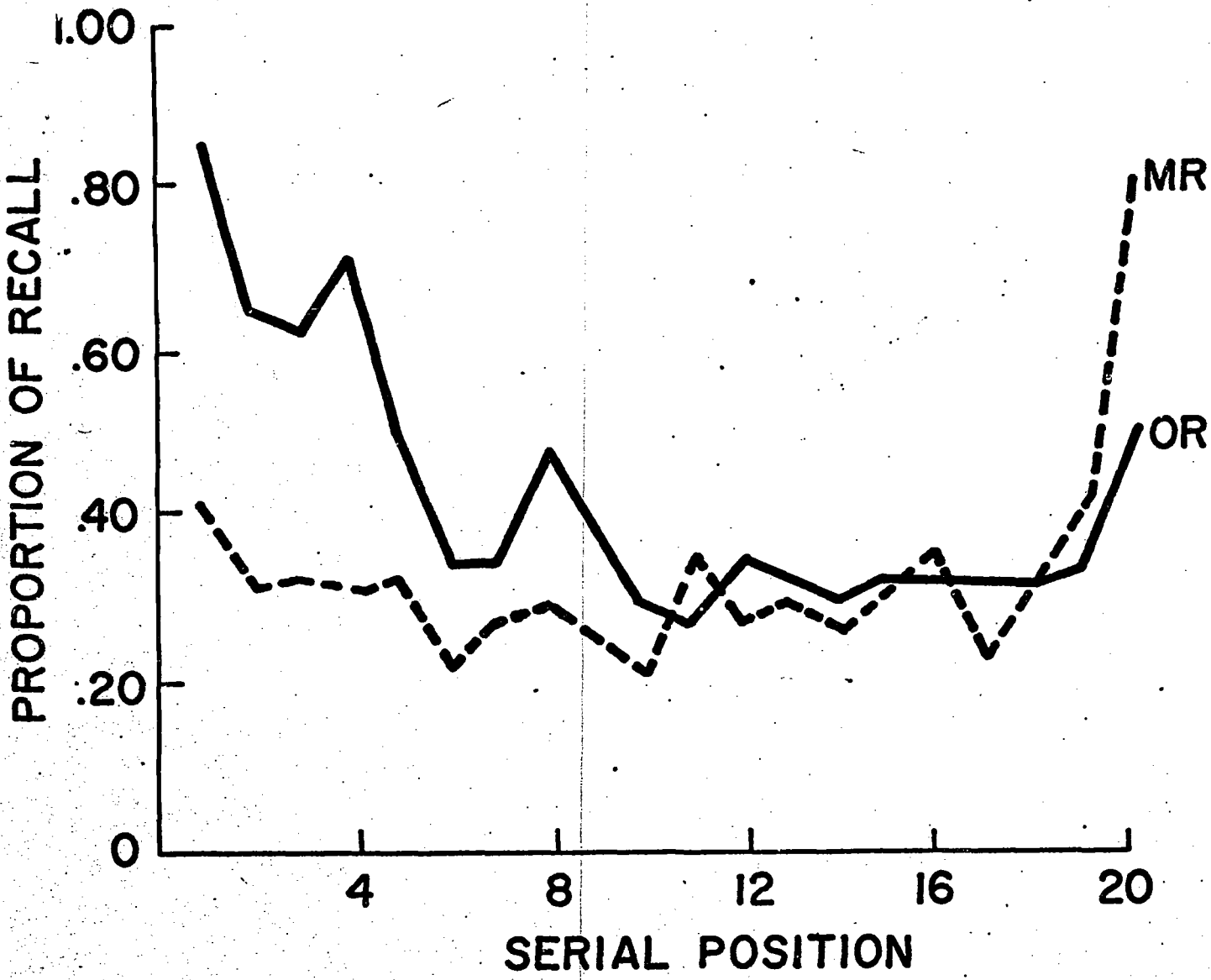
DESIGN OF EXPERIMENT I SHOWING REHEARSAL, SEX, AND GRADE AS BETWEEN SUBJECTS CONDITIONS AND INCENTIVE LEVEL AND LISTS AS WITHIN SUBJECTS CONDITIONS (n=5 per cell)

Grade	OVERT REHEARSAL		MINIMAL REHEARSAL	
	Males	Females	Males	Females
	1¢ 10¢	1¢ 10¢	1¢ 10¢	1¢ 10¢
5	Lists 1 . . . 6 LTS Recall	Lists 1 . . . 6 LTS Recall	Lists 1 . . . 6 LTS Recall	Lists 1 . . . 6 LTS Recall
8	1 . . . 6 LTS Recall	1 . . . 6 LTS Recall	1 . . . 6 LTS Recall	1 . . . 6 LTS Recall
College	1 . . . 6 LTS Recall	1 . . . 6 LTS Recall	1 . . . 6 LTS Recall	1 . . . 6 LTS Recall


Overt Rehearsal
Minimal Rehearsal
MEAN RECALL PER LIST
6
5
4
3
2
0
C
8
5
1¢
10¢
INCENTIVE LEVEL


MEAN OVERT REHEARSAL PER LIST
120
100
80
60
0
C
8
5
1¢
10¢
INCENTIVE LEVEL


1.00
.80
.60
.40
.20
0
PROPORTION OF RECALL
10¢
1¢
4
8
12
16
20
SERIAL POSITION


1.00
.80
.60
.40
.20
0
PROPORTION OF RECALL
4
8
12
16
20
SERIAL POSITION
MR
OR